



FAA-E-2583  
January 18, 1974

## DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION SPECIFICATION

### METER, PORTABLE ILS MODULATION

#### 1.0 SCOPE

1.1 Scope.- The equipment specified herein is a portable AC operated Modulation Meter utilized in measuring the modulation levels of instrument landing system (ILS) localizer and glide slope facilities, and signal generators utilized in the alignment of airborne ILS receivers. This test equipment is to be utilized in a "Closed Cable System" configuration with adequate isolation from electromagnetic propagation modes.

#### 2. APPLICABLE DOCUMENTS

2.1 FAA specifications.- The following FAA specifications, of the issues specified in the invitation for bids or request for proposals, form a part of this specification except as modified herein:

- FAA-D-2494/1 Instruction Books Manuscript Technical:  
Equipment and Systems Requirements:  
preparation of Manuscripts
- FAA-G-2100/1 Electronic Equipment, General  
Requirements: Part 1, General  
Requirements for all equipment
- FAA-G-2100/3 Requirements for Equipments Employing  
Semiconductor Devices
- FAA-G-2100/4 Requirements for Equipment Employing  
Printed Wiring Techniques

FAA-STD-013    Quality Control Program Requirements

FAA-G-2100/5   Requirements for Equipments Employing  
Microelectronic Devices

FAA-G-2100    Electronic Equipment, General Requirements  
Supplement 4   FAA list of Applicable Documents

(Copies of this specification, and the applicable FAA specifications and drawings may be obtained from the Federal Aviation Administration, Washington, D. C. 20591 ATTENTION: Contracting Officer. Requests should fully identify material desired, i.e., specification numbers, dates, amendment numbers, complete drawing numbers, in addition to the invitation for bids, requests for proposals, contract involved, or other use to be made of the requested material.)

2.2 Military specifications.- The following military specifications of the issues in effect on the date of the invitation for bids or request for proposals, form a part of this specification:

MIL-E-17555    Electronic and Electrical Equipment and  
Associated Repair Parts, Preparation for  
Delivery of

MIL-I-45208    Inspection System Requirements

MIL-STD-785    Reliability Program Plan

MIL-STD-470    Maintainability Program Plan

MIL-STD-781    Test level for Demonstration Tests

MIL-HDBK-217   Reliability, Stress and Failure Rate  
Handbook

(Information on obtaining copies of Military Specifications is given in Paragraph 1.2 of FAA-G-2100, Supplement 4, FAA List of Applicable Documents.)

### 3. REQUIREMENTS

3.1 Equipment to be furnished by the contractor.- Each equipment furnished by the contractor shall be complete in accordance with all specification requirements and shall consist of the items tabulated below. Any feature necessary for proper operation in accordance with the requirements of this specification shall be incorporated in the equipment even though that feature may not be specifically described herein. Instruction books, in accordance with FAA-D-2494/1, shall be furnished in quantities specified in the contract schedule. A single instruction book shall cover all equipment items described herein which are furnished under the contract.

- (a) 1 ea. Portable ILS modulation meter.
- (b) 1 set Wattmeter coupler (3.9).
- (c) 1 ea. RF Input cable (3.8).
- (d) 1 ea. Power cord (3.11).
- (e) 1 set Extender card (3.10).
- (f) 2 ea. Instruction book. (see contract schedule)

### 3.2 Standard Signals

3.2.1 Standard Localizer Signal.- A standard localizer signal is an RF carrier of 150 to 800 millivolt level, amplitude modulated simultaneously with 90 Hz and 150 Hz sine wave voltages, so that the sum of their separate modulation percentages equals 40%, when these separate modulation percentages are varied between 0% and 40%.

3.2.1.1 Localizer carrier frequency.- The localizer RF carrier frequency can have any value between 108 MHz and 112 MHz.

3.2.1.2 Modulation components.- The 90 Hz and 150 hz modulation voltages are in phase when positive going through zero phase each 1/30 second, while maintaining exactly a 1.5/1 and 2.5/1 frequency ratio to 60 Hz  $\pm$  1.0%.

3.2.1.3 Identification tone.- In addition to the 90 Hz and 150 Hz modulation, the localizer carrier may be simultaneously modulated with a 1020 Hz tone at a maximum modulation level of fifteen percent.

3.2.2 Standard glide slope signal.- A standard glide slope signal is an RF carrier of 150 to 800 millivolt level, amplitude modulated simultaneously with 90 Hz and 150 Hz sine wave voltages, so that the sum of their separate modulation percentages equals 80% when these separate modulation percentages are varied between 0% and 80%. These 90 Hz and 150 Hz voltages shall meet the characteristics of paragraph 3.2.1.2.

3.2.2.1 Glide Slope carrier frequency.- The glide slope carrier frequency can have any value between 328 MHz and 336 MHz.

### 3.3 Performance

3.3.1 Accuracy.- The modulation meter shall provide separate measurements of the amplitude modulation levels of the 90 Hz and 150 Hz components on the localizer and glide slope signals. These measurements shall provide a reading which is within  $\pm 0.5$  percent of the true value of the percentage modulation. This accuracy shall be obtained with a single tone modulation up to 80% or with simultaneous tones up to a modulation peak of 80%. These measurements at 90% modulation shall provide a reading which is within  $\pm 1.0$  percent of the true value of the percentage modulation. The accuracy between 80% and 90% will be a linear relationship.

3.3.1.1 Accuracy Verification.- The verification of accuracy shall be by means of a standard test generator and procedure to be specified by the Electromagnetics Division of National Bureau of Standards. The intent of this paragraph is to verify the designed accuracy of the equipment and shall not be used as a means of calibrating to the required accuracy.

3.3.2 Warmup.- This accuracy shall be obtained throughout the ambient temperature range after a maximum warmup period of ten minutes. After this warmup period and prior to making measurements, calibration and zero adjustments are permitted. Under a constant ambient condition, the accuracy must be maintained for a minimum of sixty minutes following calibration and zero adjustment, without recalibration and rezeroing.

3.3.3 Carrier variation.- The modulation measurement accuracy shall be maintained for a minimum carrier level variation of 8db, without readjustment of any control.

3.3.3.1 Display Control.- Circuitry shall be provided to block the percent modulation indication, unless the carrier level is of the amplitude necessary to achieve the accuracy of 3.3.1.

3.3.4 RF Characteristics.- The modulation meter shall be fixed tuned to separately cover the two ILS frequency bands of 108 MHz to 112 MHz and 328 MHz to 336 MHz and broadbanded to preclude the need for additional channel selection within-band.

3.3.4.1 Out of Band Rejection.- Response to RF signals 10 MHz or greater from the edge of the selected band shall be not less than 25 DB down from the response of RF signals within the selected band.

3.3.4.2 Input Impedance.- The instrument shall be designed with a nominal input impedance of 50 ohms with a VSWR of no greater than 2.0/1 throughout the selected band, and throughout the input signal range.

3.3.5 Overload Protection.- The instrument shall not be damaged by RF input signals up to 45 mw (1.5 volts rms at 50 ohms) with any control settings.

3.3.6 Calibrator.- An internal crystal controlled calibration generator shall be incorporated into the modulation meter. This calibration generator provides a signal for standardizing the measuring circuits at 42.4% modulation. This generator output shall exhibit the following characteristics:

Carrier Frequency - 110 MHz  $\pm 0.01\%$

Carrier Output level - 350 mv  $\pm 1$ db

Modulation - Square wave amplitude modulation.

Modulation Frequency - 30 Hz  $\pm$  0.1% for 90 Hz tone calibration and 50 Hz  $\pm$  0.1% for 150 Hz tone calibration. These frequencies may be derived from power line frequency.

Residual FM - Less than  $\pm$  1k Hz total frequency deviation.

#### Envelope Characteristics

Rise Time -	25 uSec max
Decay Time -	25 uSec max
Symmetry measured at 50% amplitude -	$\pm$ 20 uSec max
Droop -	$\pm$ 0.5% max
RF on/off ratio -	60db min

3.3.7 Input jack isolation.- When calibrating the modulation meter, the calibrator output is switched to the modulation meter input circuit. During calibration the presence of any signal above 30 MHz with a carrier amplitude of not less than 800 millivolts at the modulation meter input jack, shall not affect the percent modulation reading by more than  $\pm$ 0.1%. Also during calibration or normal use, the presence of any electromagnetic field above 30 MHz with a carrier amplitude of not less than 1,000 millivolts per meter shall not affect the percent modulation reading by more than  $\pm$ 0.1%.

3.3.8 90 Hz spurious modulation rejection.- With the modulation meter setup to measure the 90 Hz modulation component, response to the following modulation frequencies shall be below that of 90 Hz sine wave modulation by the amount indicated.

<u>Frequency</u>	<u>Response below 90 Hz response</u>
30 Hz -	65db
60Hz, 120Hz, 180Hz, 240Hz, 300Hz, 360Hz, 420Hz, 450Hz	40db
150 Hz -	58db
1020 Hz -	50db

3.3.9 150 Hz spurious modulation rejection.- With the modulation meter setup to measure the 150 Hz modulation component, response to the following modulation frequencies shall be below that of 150 Hz sine wave modulation by the amount indicated.

<u>Frequency</u>	<u>Response below 150 Hz response</u>
50 Hz -	65db
60Hz, 120Hz, 180Hz, 240Hz, 300Hz, 360Hz, 420Hz, 450Hz	40db

250 Hz -	54db
90 Hz -	58db
1020 Hz -	50db

3.4 Panel indicators.- Each portable ILS Modulation Meter shall provide the following panel indicators.

3.4.1 Percent Modulation Indicator.- The percent Modulation indicator shall be comprised of a three digit, seven segment incandescent display with a fixed decimal indicator between the second and third digit. The characters shall be a minimum height of 0.4 inch and have a slant of 5° or less to the vertical. An optical filter shall be provided to minimize the effects of ambient illumination. Without the filter, the characters shall have a light output of at least 6000 ft. lamberts with a nominal segment current of 20 ma at rated voltage.

3.4.2 Carrier level indicator.- A carrier level meter shall be provided with appropriate markings to indicate its zero position and the nominal carrier level. The carrier level indication facilitates the sensitivity adjustment of the modulation meter.

3.5 Panel mounted controls.- Each portable ILS Modulation Meter shall provide the following panel mounted controls.

3.5.1 Level control.- A continuously adjustable control which provides variation of the equipment sensitivity to accommodate the RF input and calibration signal variations (3.2.1, 3.2.2, 3.3.6).

3.5.2 Tone switch.- A two position switch to select either the 90 or 150 Hz modulation component for measurement.

3.5.2.1 150 Hz position.- Placing the tone switch in the 150 Hz position establishes proper interconnections to measure the 150 Hz modulation component of the input signal when the function switch is in either the localizer or glide slope position.

3.5.2.2 90 Hz position.- Placing the tone switch in the 90 Hz position establishes proper interconnections to measure the 90 Hz modulation component of the input signal when the function switch is in either the localizer, or glide slope position.

3.5.3 Function selector switch.- The function selector switch shall be provided with five positions, zero adjust, glide slope, localizer, calibration 90 Hz, calibration 150 Hz. Selection of one of these positions provides the proper interconnections to permit the modulation meter to perform the function selected.

3.5.3.1 Glide slope.- The glide slope position of the function switch provides proper interconnections to permit the detection and measurement of glide slope signals present at the input jack.

3.5.3.2 Localizer.- The localizer position of the function switch provides proper interconnections to permit the detection and measurement of localizer signals present at the input jack.

3.5.3.3 Calibration 90 Hz.- The calibration 90 Hz position of the function switch provides interconnection to place the internal calibration generator output (3.3.6) at the input to the localizer detection circuitry, and to connect the detection output to the 90 Hz measuring circuits.

3.5.3.4 Calibration 150 Hz.- The calibration 150 Hz position of the function switch provides interconnection to place the internal calibration generator output at the input to the localizer detection circuitry and to connect the detection output to the 150 Hz measuring circuits.

3.5.3.5 Zero adjust.- Placing the function switch in the zero adjust position provides proper interconnections to isolate the detector circuitry from the external and calibrator RF input and activates the modulation measuring and display circuits.

3.5.4 Zero and Calibration Adjustments.- These controls shall be recess mounted to minimize the possibility that the setting will be disturbed accidentally. If the control effects the percent modulation indication, the range of the control shall be such that a 30° rotation of the control will not change the display by more than 0.1%.

3.5.4.1 Carrier zero adjust.- A continuously screwdriver adjustable control mounted adjacent to the level indicator (3.4.2), to provide carrier circuitry zero adjustment when the function switch (3.5.5) is placed in the zero adjust position.

3.5.4.2 Display zero adjust.- A continuously screwdriver adjustable control mounted adjacent to the percent modulation digital display (3.4.1), which provides zero adjustment of the digital display circuits when the function selector switch (3.5.3) is placed in the zero adjust position.

3.5.4.3 90 Hz calibration adjustment.- A continuously screwdriver adjustable control mounted adjacent to the calibration 90 Hz position of the function selector (3.5.3), which provides adjustment of the gain of the 90 Hz modulation measuring circuitry.

3.5.4.4 150 Hz calibration adjustment.- A continuously screwdriver adjustable control mounted adjacent to the calibration 150 Hz position of the function selector (3.5.3), which provides adjustment of the gain of the 150 Hz modulation measuring circuitry.

3.6 Service conditions.- Service conditions shall be as defined in paragraph 1-3.2.23, FAA-G-2100/1 with 120V AC design center input and Environment II thereof, except that the ambient temperature range shall be 0°C to 50°C. The AC line frequency shall be 60 Hz  $\pm$  1% when testing the calibrator modulation frequency, if the modulation frequency is derived from the power line.

3.7 Design.- The modulation meter shall be designed in accordance with the requirements of FAA-G-2100/1, except as modified herein.

3.7.1 Electron devices.- No electron tubes shall be incorporated in the equipment design. Diodes and transistors shall be in accordance with FAA-G-2100/3. Micro-electronic devices shall be in accordance with FAA-G-2100/5.

3.7.2 Weight.- The weight of the modulation meter with cover attached, but excluding cables and couplers shall not exceed 20 pounds.

3.7.3 Printed circuit boards.- Circuits shall be mounted on plug-in printed circuit boards with printed wiring in accordance with FAA-G-2100/4. All plug-in boards shall be keyed so that it is not possible to inadvertently plug them in the wrong connector. Also, the card extenders and associated printed circuit boards shall be keyed so that it is not possible to reverse a printed circuit board when using the extender card. All printed circuit boards shall be field repairable using procedures described in the instruction book furnished and test equipment commonly available at field installations (3.13).

3.7.4 Cabinet.- The equipment shall be mounted in a cabinet with dimensions not exceeding a volume of one cubic foot including the front cover (3.7.4.2), but excluding the handle. No dimension (length, width, depth) shall exceed any of the other dimensions by a factor greater than two. The cabinet material shall be aluminum alloy or magnesium alloy. Metal thickness shall be adequate to meet the structural strength requirement and shall be not less than 0.060 inches thick. The equipment shall be easily removable from the cabinet for servicing. Four rubber feet shall be mounted on the bottom of the unit to allow the unit to be rested on a hard surface without marring the finish.

3.7.4.1 Louvers.- Louvers are not permitted on the cabinet.

3.7.4.2 Cabinet cover.- A front cover shall be included which is attached to the cabinet with separatable hinging. In the fully open position, the cover may swing under the base of the cabinet, providing an improved viewing angle for the instrument.

3.7.4.3 Storage in cabinet.- Space shall be provided below the Modulation Meter mounting within the cabinet, of sufficient dimensions to store the input cable, power cord and an instruction manual. A suitable mounting clip shall be provided within the cabinet cover to store the wattmeter couplers.

3.7.4.4 Cabinet handle.- An appropriate handle shall be fastened over the point of balance on the top of the cabinet such that the instrument is easily carried by one person.

3.7.4.5 Front panel layout.- The connectors, controls, displays, meters, etc., that are mounted on the front panel shall be arranged in a logical manner which maximizes effective application of the equipment. The front panel layout drawings shall be submitted to the FAA for approval.



3.7.4.6 Finish.- The cabinet, cover, and front panel shall be finished in accordance with FAA-G-2100/1 except that a smooth gray enamel matching color No. 16314 of Federal Standard 595 shall be used. (Modifies Paragraph 1-3.8.2 of FAA-G-2100/1)

3.7.5 Front panel marking.- All front panel mounted controls and parts shall be marked to clearly designate their function. The front panel marking drawings shall be submitted to the FAA for approval.

3.7.6 Reliability and Maintainability.- The equipment shall be designed for reliability and maintainability using MIL-STD-785, MIL-STD-470, MIL-STD-781 and MIL-HDBK-217 for guidance. The following specific requirements are considered the minimal acceptable response to these standards:

MTBF	25,000 hours
MTTR	1.0 hour
MPMT	0.5 hour/month

3.7.6.1 Reliability Program Plan.- The contractor shall perform a reliability analysis of the proposed design for the equipment to determine compatibility with the required MTBF. A failure rate shall be assigned to each part in accordance with the data presented in the latest revision to MIL-HDBK-217. Parts not included in the coverage of MIL-HDBK-217 shall be assumed to possess the failure rate of the most similar part in the coverage. Where this is unrealistic, any valid existing data shall be used upon approval of the Government. The analysis, including a mathematical model with block diagrams, shall be submitted to the Government in accordance with the contract schedule. The analysis shall include a comparison of the predicted MTBF for the equipment with the required MTBF. Where the predicted figure is less than the requirement, the contractor shall accomplish such changes in design as are necessary to raise the predicted MTBF to the required value prior to production and demonstration.

3.7.6.2 Reliability Demonstration.- MIL-STD-781B plan #XXV with a discrimination ratio of 3/1 and a risk of 30 percent shall be used by the contractor to demonstrate reliability. Test duration for this plan is 0.37 times the specified MTBF per unit and is equal to 9,250 hours. To reduce test time not less than 10 units may be demonstrated for 925 hours. This is the minimum testing provided no calibration failures have occurred. The reliability demonstration test procedures shall be submitted to the Government for approval.

3.7.6.3 Failure Criteria.- Instrument integrity is the prime goal of the demonstration test rather than its capability to run continuously for a specified number of hours. Calibration failures are those which will allow the instrument to be calibrated erroneously. Functional failures are any failures which affect usability. Providing no failure pattern is established, a total of 10 functional failures will be permitted during the above reliability demonstration.

3.7.6.4 Maintainability.- The equipment shall be designed and constructed to minimize skill, experience and time necessary to disassemble, assemble, and maintain it. The MTTR shall not exceed one hour, assuming repair time has a log-normal distribution. At least ten faults, to be selected by the Government, shall be simulated to demonstrate compliance with the MTTR requirements. The maintainability program plan and maintainability demonstration test procedures shall be submitted to the Government for approval.

3.7.6.5 Preventative Maintenance.- The mean preventative maintenance shall not exceed 30 minutes average per month including periodic checks to validate performance and to recalibrate, if required.

3.8 Input cable.- An eight foot long input cable shall be supplied by the contractor for connection to the signal source. This overall length includes connectors and its tolerance shall be within plus and minus one inch. The cable shall be RG58/U or equivalent with UG88/U or equivalent connectors attached to both ends.

3.9 Wattmeter couplers.- Wattmeter couplers shall be provided by the contractor. These couplers, provided with a BNC jack, shall be mechanically interchangeable with the detector element of the Bird Electronic Corporation Model 43 Wattmeter. When the couplers are placed in position in a wattmeter which is connected to a transmitter output line, proper levels are available at the coupler jack to operate the modulation meter. The coupling shall be fixed and shall provide proper output levels for transmitter power between 1 to 10 watts at the glide slope frequency and 10 to 200 watts at the localizer frequency.

3.10 Extender card(s).- To facilitate maintenance and trouble shooting each modulation meter shall include an extender card(s) suitable for gaining access to all plug-in printed circuit boards. It (they) shall be mounted within the instrument case in a readily removable manner, and shall meet the requirements of paragraph 3.7.3.

3.11 Power cord.- A 96 inch, 3 wire power cord shall be supplied by the Contractor, which mates with Switchcraft LAC3GD connector, and is supplied with a 3 prong 120V grounding plug.

3.12 Nameplate.- A nameplate, in accordance with FAA-G-2100/1 shall be provided on the cabinet cover. The equipment title shall be:

METER, PORTABLE ILS MODULATION

In addition, the equipment title and FAA type designation shall be indicated on the instrument front panel.

3.13 Test Equipment.- A list of the types of test equipment commonly available at FAA facilities for maintenance of this equipment shall be provided by the contracting Officer or his designated Technical Officer upon receipt of a written request from the contractor.

4. QUALITY ASSURANCE PROVISIONS

4.1 Quality Control Provisions.- The contractor shall be responsible for the inspection and testing of equipment and materials for conformance to specification requirements and shall utilize for this purpose, a quality control program in accordance with FAA-STD-013. Specific requirements shall be as specified in Section 1-4 of specification FAA-G-2100/1.

5. PREPARATION FOR DELIVERY

5.1 General.- Unless otherwise specified in the contract, the equipment shall be prepared for domestic shipment in accordance with the following subparagraphs.

5.2 Preservation and packaging.- Preservation and packaging shall be in accordance with specification MIL-E-17555, level A.

5.3 Packing.- Packing shall be in accordance with specification MIL-E-17555, level B.

5.4 Marking.- Each package and shipping container shall be durably and legibly marked with the following information:

Name of Item and FAA Type Number  
Serial Number(s)  
Quantity  
Contract Number  
Federal Stock Number (To be supplied by FAA)  
Gross Weight of Container  
Manufacturer's Name

6. NOTES

6.1 Notes.- None

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